UTILIZATION OF PROTECTED AND UNPROTECTED RAPESEED BY LACTATING DAIRY COWS

By David A. Christensen, Marlene Cochran and G. Steacy
Department of Animal and Poultry Science
University of Saskatchewan,
Saskatoon, Saskatchewan, Canada

The need for high intakes of energy and protein by dairy cows in early lactation is well documented as is the detrimental effect of high levels of dietary lipids on rumen function (Storey et al.,1973). Low glucosinolate rapeseed meal has been shown to be equal to soybean meal as a protein source for lactating dairy cows (Laarveld and Christensen,1976). The protection of lipids through the use of formaldehyde-treated protein has been described for use in ruminant rations (Scott, Cook and Mills,1971). The following two studies were conducted to determine the effects of protected and unprotected lipids on milk production and metabolism in lactating dairy cows.

In Trial 1, a commercially produced protected soybean-tallow product was compared to a protected Tower rapeseed product (low glucosinolate) and to high and low forage control rations in a double 4x4 latin square feeding trial using eight lactating Holstein-Friesian cows. The duration of each feeding period was 28 days and production, metabolic and feed intake data were collected over the final 10 days of each period. The four rations consisted of: 1) a low forage (35% alfalfa-bromegrass hay) ration, 2) a high forage (50% alfalfa-bromegrass hay) ration, 3) a low forage ration containing 8% protected tallow-soybean product and 4) a low forage ration with 8% protected Tower rapeseed product. All rations were formulated to meet or exceed National Research Council (NRC, 1971) nutrient requirements and the protected lipid rations tended to have higher protein and energy levels than the control rations. Blood samples were taken 3 hours after the morning feeding.

Trial 2 was conducted to obtain production and metabolism data when Candle (low glucosinolate) or Tower rapeseed were fed in the unprotected form and compared to a low lipid soybean meal control concentrate. The four rations consisted of 40% chopped alfalfa-bromegrass hay and 60% concentrate as fed. The control ration contained 2.2% ether extract and soybean meal supplied supplementary protein. The second ration contained 6.3% Candle rapeseed (5.0% ether extract in ration dry matter), the third ration 12.6% Candle rapeseed (8.0% ether extract) and the fourth ration 11.2% Tower rapeseed (8.0% ether extract). Protein, calcium, phosphorus and other nutrient levels were adequate to meet or exceed NRC (1971) requirements. The whole rapeseed was mixed with the concentrate portion of the ration which was then pelleted (0.48 cm diameter) thus crushing the rapeseed. Blood and rumen samples were taken 5 and 3 hours respectively after feeding.

In Trial 1 protected Tower rapeseed significantly increased 4% fat corrected milk (4% FCM) yield ($P<0.05$) over the other three rations (Table 1). Protected Tower rapeseed increased actual milk yield over the two control rations but not over the protected soy-tallow ration. Milk fat percentages were not different but tended to be higher on the high forage control and protected Tower rapeseed rations. Fat and total solids yields were significantly greater on the protected rapeseed ration than on the other three rations. Protein yield was not affected by ration. Feed required per 100 kg of 4% FCM was lower ($P<0.05$) on the protected Tower rapeseed ration compared to the two control rations. Although crude protein intake was highest when the Tower rapeseed was fed, it is unlikely that the response was due to additional protein as the intake on all rations exceeded the estimated requirement, and blood urea nitrogen (BUN) levels did not indicate inadequate protein intakes on the other three ration. Plasma

Table 1. THE EFFECT OF RATION FORAGE LEVEL AND PROTECTED LIPID SOURCE ON MILK PRODUCTION, FEED INTAKE AND BLOOD CHEMISTRY, TRIAL 1.

	Low Forage Control	High Forage Control	Protected Soy-Tallow	Protected Tower Rapeseed	SE
Milk yield, Kg/day	28.6^{bc}	27.3^{c}	30.4^{ab}	31.7^{a}	0.85
4% FCM, Kg/day	25.5^{c}	26.0^{bc}	27.8^{b}	30.4^{a}	0.63
Fat, %	3.26	3.73	3.43	3.77	0.19
Protein, %	3.61	3.27	3.05	3.06	0.21
Total solids, %	11.94	12.47	11.77	12.23	0.19
Fat yield, Kg/day	0.94^{b}	1.00^{b}	1.04^{b}	1.18^{a}	0.04
Protein yield, Kg/day	1.03	0.89	0.93	0.97	0.06
Total solids yield, Kg/day	3.42^{b}	3.39^{b}	3.58^{b}	3.87^{a}	0.09
Dry matter intake, Kg/day	19.7	19.7	20.3	20.6	0.43
Kg dry matter/100 Kg 4% FCM	85^{a}	82^{a}	74^{ab}	69^{b}	4.0
Crude protein intake, Kg/day	2.82^{c}	2.87^{c}	3.14^{b}	3.33^{a}	0.06
Plasma calcium, mg/dℓ	9.38	9.44	7.90	9.08	0.38
Plasma phosphorus, mg/dℓ	4.26	5.16	4.89	4.21	0.30
Plasma cholesterol, mg/dℓ	157^{c}	153^{c}	230^{b}	289^{a}	5.5
Blood urea nitrogen, mg/dℓ	13.4	14.5	14.0	13.4	0.87

$^{a-c}$Means in the same row with different letters differ ($P<0.05$).

cholesterol was elevated ($P<0.05$) by both protected lipid diets with Tower rapeseed causing the greatest increase. Plasma calcium and phosphorus levels were not affected by the ration with the exception of a trend toward lower plasma calcium ($P<0.10$) on the soy-tallow ration.

In Trial 2 milk production and milk composition were not significantly affected ($P>0.05$) by level or type of unprotected rapeseed (Table 2). Feed and protein intakes were uniform across treatments and digestibility of energy and protein was not affected by ether extract level or inclusion of rapeseed in the ration. Although the digestibility of energy tended to be lower for all three rapeseed containing rations they were not significantly lower ($P>0.05$) than the control ration. Plasma calcium and phosphorus levels were unaffected by treatment but both plasma cholesterol and triglycerides were elevated by all rapeseed rations ($P<0.05$). The reason for the depression of BUN with Candle rapeseed at both levels is not certain, but may be related to a reduced rate of degradation of protein in the rumen when that cultivar was fed. There was no evidence of reduced protein digestibility in the Candle rapeseed rations. Total rumen VFA levels were unaffected by dietary ether extract level and were in the expected range. The depressed acetate-propionate ratio reflected the low dietary crude fiber levels (15 to 16% of ration dry matter), and may have caused the depression in milk fat percentage. The inclusion of whole unprocessed rapeseed in the ration did not affect production or digestibility, and with the exception of reduced BUN when Candle rapeseed was fed, normal metabolic responses were observed.

Protected Tower rapeseed comprising 8% of a low forage ration (35% hay) increased 4% FCM and fat and total solids yields over those observed on the protected soy-tallow ration, the 50% forage ration or the 35% forage control ration. A similar response in milk yield was not observed when unprotected Candle rapeseed was fed at a similar level or when unprotected Candle and Tower rapeseed were fed at higher levels. However, milk yields and normal rumen function were maintained on the high Candle and Tower rapeseed rations which contained approximately 8% ether extract.

Table 2. THE EFFECT OF PROTEIN SOURCE AND RATION ETHER EXTRACT LEVEL ON MILK PRODUCTION, FEED UTILIZATION AND BLOOD AND RUMEN CHEMISTRY, TRIAL 2.

Protein Source:	Soybean-meal Control	Candle Rapeseed	Candle Rapeseed	Tower Rapeseed	SE
Ether Extract Level:	2.2	5.0	8.0	8.0	
Milk yield, Kg/day	27.7	27.6	26.8	25.7	0.64
4% FCM, Kg/day	20.0	18.8	20.3	20.1	0.73
Fat, %	2.21	1.91	2.39	2.51	0.20
Protein, %	3.18	3.28	3.23	3.31	0.09
Total solids, %	10.68	10.67	11.06	11.15	0.16
Fat yield, Kg/day	0.59	0.52	0.64	0.65	0.05
Protein yield, Kg/day	0.88	0.90	0.87	0.85	0.03
Total solids yield, Kg/day	2.94	2.94	2.97	2.88	0.06
Dry matter intake, Kg/day	16.9	16.4	16.0	16.3	0.28
Crude protein intake, Kg/day	2.60	2.51	2.52	2.55	0.06
Kg dry matter/100 Kg 4% FCM	85	89	85	86	4.0
Digestibility of energy, %	65.2	63.9	60.8	62.2	1.63
Digestibility of protein, %	68.8	68.9	67.6	67.8	1.18
Plasma calcium, mg/dℓ	9.83	10.26	10.33	10.11	0.18
Plasma phosphorus, mg/dℓ	6.96	6.13	6.01	5.73	0.33
Plasma cholesterol, mg/dℓ	135^{a}	219^{b}	216^{b}	253^{b}	12.15
Blood urea nitrogen, mg/dℓ	13.0^{a}	9.1^{b}	10.3^{b}	11.3^{ab}	0.74
Plasma triglycerides, mg/dℓ	21.6^{a}	27.5^{b}	28.0^{b}	26.5^{b}	1.02
Hemoglobin, g/dℓ	13.3	12.2	12.4	12.2	0.40
Packed cell volume, %	35.9	33.5	33.4	33.1	1.13
Total rumen VFA, mg/dℓ	105	114	111	106	8.33
Acetate-propionate ratio	1.78:1	1.54:1	1.72:1	1.60:1	0.17

$^{a-b}$Means in the same row with different letters differ ($P<0.05$).

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